WAVE-MOTION ARDUINO SHIELD

EGR 326 - Embedded System Design
Fall 2011
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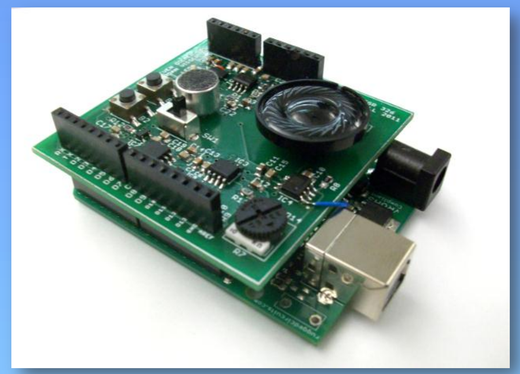
Project Motivation

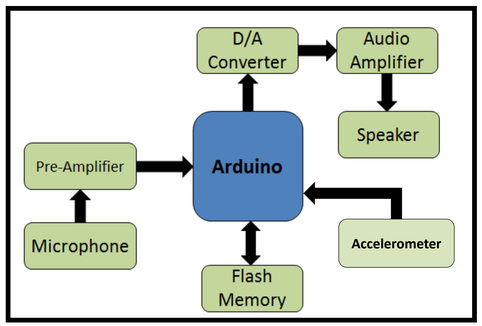
The shield was largely inspired by the Yak-Bak, a popular toy from the late 1990s that could record audio and play it back at a different frequency/pitch depending on the position of a knob. In principle, the Wave-Motion Shield has much the same functionality as the Yak-Bak. However, the pitch, or frequency, at which the sound is played back, is controlled by the orientation or movement of the shield (of which is measured by an accelerometer).



Wave-Motion

The Wave-Motion Shield was designed as a novelty device that would allow one to record a message and play back the recording at different speeds based on accelerometer readings (certain motions increase the playback speed while others decrease playback speed). The Wave-Motion Shield can also play pre-recorded sounds triggered by unique movements of the shield.

Design



Flash Memory - Stores audio in sequential addresses as byte values.

D/A Converter – Converts the digital byte values saved in the flash memory to an analog signal.

Audio Amplifier– Provides current amplification to the D/A Converter's signal.

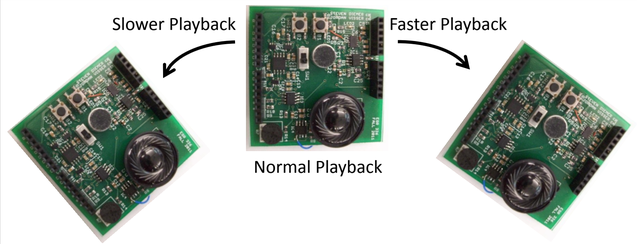
Speaker– Converts an electrical signal, to sound.

Accelerometer– Used to determine the orientation or motion of the shield.

Microphone - Converts sound, a mechanical wave, into an electrical signal.

Pre-Amplifier - Amplifies the microphone signal (<10mV) to the range of 0V-5V.

Playback Control



The Wave-Motion Shield adjusts the playback speed by increasing or decreasing the rate at which data is read from memory and output to the DAC. This stretches or condenses the audio signal and effectively decreases or increases the frequency of the recording. By sampling the accelerometer intermittently while playing back audio, accelerometer readings are processed and the playback speed is adjusted appropriately.

Results

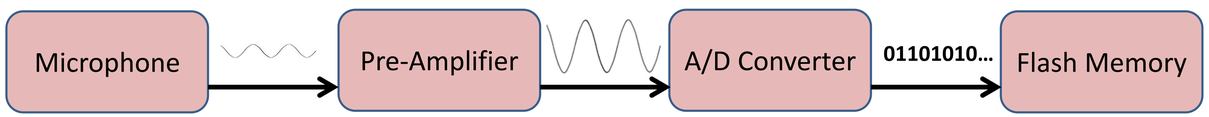
- **Audio Recording (16KHz Sampling Rate with 10-Bit Depth)**
- **120 Seconds of Audio Storage (at 16KHz/10-Bit)**
- **Accelerometer Controlled Variable Playback**
- **Gesture Interfaced Sound Effect Playback**

Acknowledgements

Thank you to those who provided invaluable guidance and aid.

Professor Andrew Sterian
Robert Afton
Mathew Smith

Recording



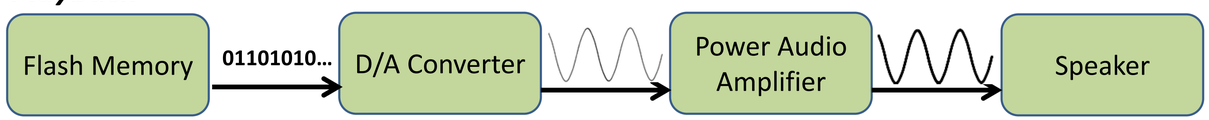
A small condenser microphone converts sound to a small electrical signal.

The pre-amplifier uses components tuned to provide a negative feedback/gain configuration to amplify the microphone signal in the range of 2.5 +/- 2.5VDC.

The ADC on the Arduino samples the analog voltage and converts the voltage to a digital 10-bit value.

Each A/D Conversion value is written to sequential addresses on the 32Mbit flash memory.

Playback



A 10-bit value is read from flash memory beginning at the address of the first recorded byte.

The DAC converts the discrete 10-bit value from flash memory to a low power analog voltage.

A 1-Watt power audio amplifier current amplifies the signal from the DAC (effectively increasing the signal's power).

The signal reaches the speaker and is converted to sound.